METHOD AND APPARATUS FOR IMAGE PROJECTION, AND APPARATUS CONTROLLING IMAGE PROJECTION

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method and apparatus for projecting an image on a three-dimensional curved surface as well as to an image projection control apparatus for controlling the image projection on a three-dimensional curved surface.

2. Description of the Prior Art

An image projection apparatus is known for projecting a still image on a fixed planar object, such as a so-called overhead projector. Also known is an image projection apparatus for projecting an image of a moving picture on a fixed planar object, such as a film projection device.

The conventional image projection apparatus is, thus, designed to project an image on the stationary planar object. Therefore, the conventional image projection device has found only limited application.

SUMMARY OF THE INVENTION

The present invention overcomes the above-mentioned deficiency, and is aimed at providing an image projection method and apparatus for projecting an image on an object other than a stationary planar object, and an image projection control apparatus for controlling the image projection.

For accomplishing the above object, the present invention provides an image projection apparatus for projecting an image on a moving three-dimensional curved surface, including a position detection portion for detecting the position of the cured surface, a projection portion for projecting an image on the curved surface, and a control portion for performing control to create an image to be projected on the curved surface to project the created image by the projection portion on the curved surface based on the position of the curved surface as detected by the position detection portion.

The present invention also provides an image projection method for projecting an image on a moving three-dimensional curved surface, including detecting a position of the curved surface, preparing an image to be projected on the curved surface and projecting the prepared image on the curved surface based on the position of the detected curved surface.

The present invention further provides an image projection control apparatus for controlling the projection of an image for the moving three-dimensional curved surface, wherein control is performed so that an image to be projected on the curved surface will be created based on the position of the inputted curved surface and so that the created image will be projected on the curved surface.

DESCRIPTION OF THE DRAWINGS

FIG. **1** a block diagram showing a schematic structure of an image projection apparatus;

FIG. **2** shows an example of the using state of the image projection apparatus;

FIG. **3** is a lock diagram showing a specified example of the image projection apparatus;

FIG. **4** shows the state of image projection on a mask by the image projection apparatus;

FIG. **5** shows markers fitted on a mask;

FIG. **6** illustrates calibration of the image projection apparatus;

FIG. **7** shows a flowchart illustrating the operation of the image projection apparatus;

FIG. **8** illustrates the use of a Kalman filter in the image projection apparatus;

FIG. **9** is a flowchart showing a step of image projection of the image projection apparatus;

FIG.**10** shows a flowchart for illustrating the step of predicting a marker position;

FIG. **11** shows a flowchart for illustrating the step of predicting an attitude and/or a position; and

FIG. **12** shows another embodiment of the image projection apparatus of the present invention.

DETAIL DESCRIPTION OF THE PREFERRED EMBODIMENTS

The image projection apparatus according to the present invention includes a camera **1**, used as an image pickup device for detecting the position and orientation of a curved surface of an object on which an image is to be projected, a computer **3** for processing an image being projected based on image pickup signals from the camera **1**, and a projector **2** for projecting the image from the computer **3** on the curved surface under consideration.

The image projection apparatus of the present embodiment is used for a configuration shown, for example, in FIG. **2**. In the present embodiment, the curved surface, as an object for image projection, is assumed to be a mask **11** worn by a person **10**. Although the mask **11** is preferably white in color to display an image formed by the projector **2**, it is not limitative. There is shown in the drawing an image projection apparatus, made up of the camera **1**, projector **2** and the computer **3** on a desk **101**, at a pre-set distance from the person **10** under consideration.

In the image projection apparatus, the camera **1** images the mask **11** set on the head of the person **10** to output image signals. The computer **2** detects the attitude or the position of the mask **11** from the image signals from the camera **1** to prepare an image of a face from the image signals of the camera **1**. The projector **2** projects an image of the face prepared by the computer **3** on the mask **11**. The person **11** is able to control the expressions of the image of the face projected on the mask by an expression control signal input device **12**.

Although a device such as a remote controller is drawn on the expression control signal input device **12**, the expression control signal input device **12** can, of course, be directly connected to the computer **3**. As this expression control signal input device **12**, a keyboard, for example, may be employed.

The camera **1**, constituting the image projection apparatus of FIG. **1**, detects an image incident from the mask **11** as a three-dimensional curved surface by a two-dimensional image frame. The camera **1** may, for example, be a so-called CCD image pickup device, formed of a two-dimensional array of plural charge-coupled devices (CCDs) as image pickup elements. The camera **1** outputs image signals of, for example, the NTSC (National Television System Committee) system.

The computer **3** is made up of a marker follower **31** for detecting the positions of markers on the mask **11** to pursue the mask **11**, an attitude and/or position prediction unit **32** for predicting the attitude and/or position such as the direc-